A COMMENSAL SARCOPHAGID (DIPTERA: SARCOPHAGIDAE) IN *NEPENTHES MIRABILIS* (NEPENTHACEAE) PITCHERS IN AUSTRALIA

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Abstract

Larvae of *Sarcosolomonia papuensis* Shinonaga and Kurahashi, are recorded from *Nepenthes mirabilis* (Lour.) Druce pitchers at Iron Range, Cape York Peninsula, Queensland. This species was previously known only from mainland New Guinea. The unusual form of the larvae is described and illustrated. Prominent creeping welts on the body enable the larvae to move up the smooth pitcher wall and amongst the pitcher fluid contents. Larvae are saprophagous and apparently leave the pitcher to pupate.

Introduction

Plants of the genus *Nepenthes* L. are well known botanical curiosities because the leaf apex is often modified into a large, tubular, insect-trapping pitcher. There are about 68 species distributed from Madagascar, the Seychelles, Indomalaysia, southern China to northern Australia and New Caledonia. *Nepenthes* spp. distribution seems to be centred on Borneo, with 28 species (Beaver 1983). Only the most widespread species, *N. mirabilis,* is in Australia. It is found on Cape York Peninsula south to Coen with a population known as far south as Innisfail, Queensland. The plants are often found in poor soil surrounding swamps (Stanley 1982).

Nepenthes spp. trap and digest insects and other arthropods that fall into the pitchers. Mature pitchers are partly filled with a fluid that contains digestive enzymes secreted by the plant and which break down the prey. Insects which fall into the fluid are prevented from escaping by the smooth internal wall of the pitcher.

Some animals, particularly insect larvae, can live unharmed in the pitcher fluid and sustain themselves on the decaying pitcher prey. Amongst insects, the fauna includes many dipterous larvae, eg. members of the families Culicidae, Ceratopogonidae, Chironomidae, Phoridae, Syrphidae, Calliphoridae, Sarcophagidae, Muscidae and Tachinidae. Larval Odonata and Lepidoptera have also been recorded (Beaver 1983). Ecological studies on *Nepenthes* pitcher communities were made by Beaver (1985) and

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Kitching and Pimm (1985).

In Australia, larvae of 3 species of mosquitoes have been found in pitchers (Marks 1980) and also larvae of Ceratopogonidae (M. Elson-Harris pers. comm.).

Larvae of *Sarcosolomonia papuensis* Shinonaga and Kurahashi were collected from pitchers at Iron Range, Cape York Peninsula, Queensland. This is the first record of this species in Australia and the first record of sarcophagid larvae from Australian *Nepenthes* pitchers. (These larvae are of the same species as those provisionally identified as Syrphidae (Monteith 1974, Kitching and Pimm 1985).)

Methods and Results

Iron Range (12°43'S 143°17'E) is situated on the eastern coast of Cape York Peninsula. Two of us (DKY and GBM) visited this locality in December 1985 and sampled pitchers growing in lowland heath along the road just north of Mt Tozer.

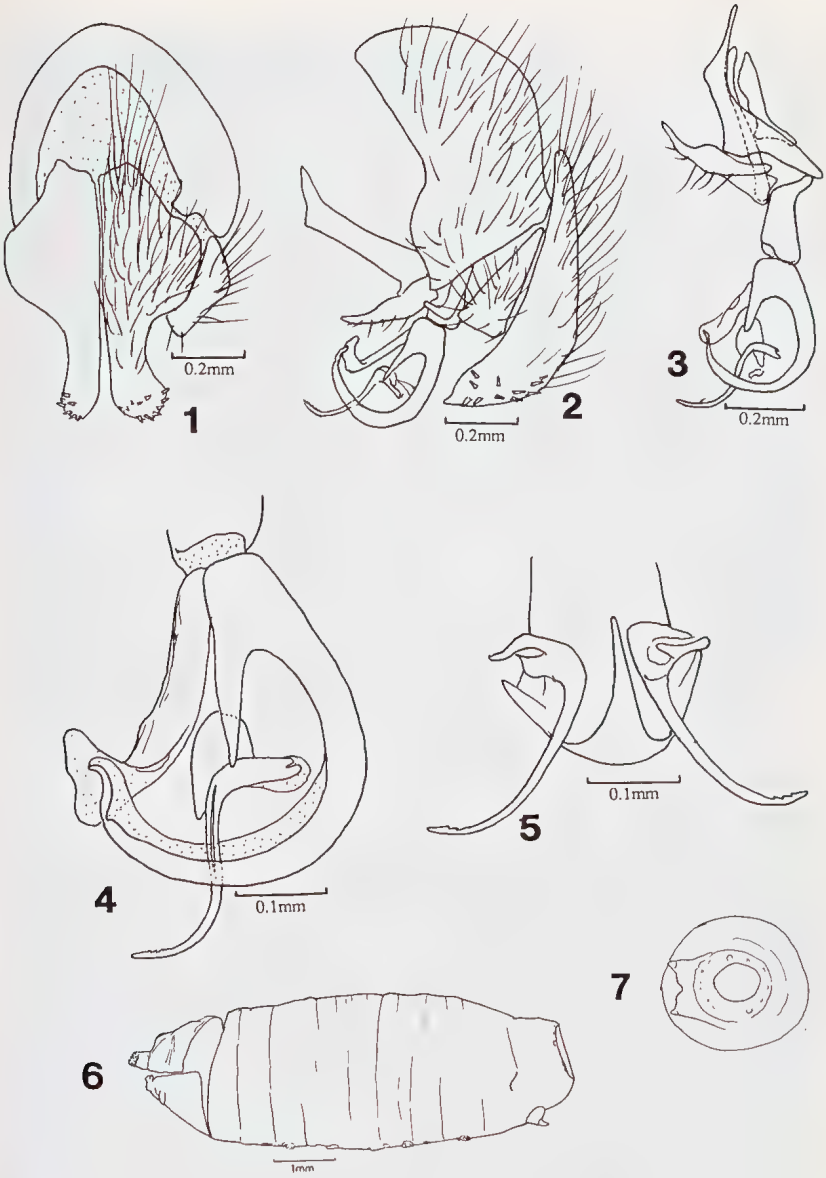
Adults reared from larvae were identified as *S. papuensis* by one of us (HSL). However, there are some minor differences in the male genitalia between the mainland New Guinean (Figs 4 and 5 in Shinonaga and Kurahashi 1969) and Cape York (Figs 1-5) populations, particularly in the shape of the cerci and parameres. This species was previously known only from Ifar in Irian Jaya.

Voucher specimens of larvae and adults are lodged in the University of Queensland Insect Collection and the Queensland Museum.

Morphology of larva and puparium

Mature larvae are 10-12 mm long and yellow-white (Fig. 8). The large anal segment is elevated at about 45° to the longitudinal axis of the body and contains a large cup-shaped respiratory cavity typical of Sarcophagidae (Fig. 9). The rim of the cavity is furnished with hairs (Fig. 10) which may prevent fluid from entering the spiracles. The cavity is closed during submersion. Just below the cavity are the long anal tubercles (Fig. 8). There are 6 pairs of prominent lobe-like creeping welts on the ventral surface (Figs 11-12) and other pairs of smaller welts on the lateral surface between the ventral welts. Most of the body surface is covered in posteriorly directed spines (Figs 13, 15) which form recurved hooks on the creeping welts (Figs 13-14).

The puparium (Figs 6-7) has anterior spiracles displaced from the anterior end and the creeping welts of the ventral surface reduced. The spiracular cavity is only slightly elevated with small tubercles, the outer dorsal tubercle is the most prominent.



Figs 1-7. *Sarcosolomonia papuensis*, male from Iron Range: 1, cerci and right paramere, caudal view (vestiture of left cercus and left paramere omitted); 2, genitalia, lateral view; 3, aedeagus, lateral view; 4-5, tip of aedeagus: 4, lateral view; 5, ventral view; 6-7, puparium: 6, lateral view; 7, posterior view showing anal segment.

Observations on the larvae

Larvae of various sizes were found in pitchers floating at the liquid surface with the respiratory cavity (see above) open. Most were found singly but occasionally 2 or 3 were found in a single pitcher. Most pitchers containing sarcophagids also contained mosquito larvae. When disturbed, the *S. papuensis* larvae moved down amongst the insect carcasses at the tapering base of the pitcher. Green tree ants (*Oecophylla smaragdina* F.) comprised the majority of prey. By transferring the contents of a number of pitchers into clear plastic vials we found that the larvae were saprophagous, feeding on dead insects in the pitcher. Often the larvae would feed with the posterior spiracles exposed at the fluid surface but sometimes they would completely submerge, closing the cavity around the posterior spiracles. Larvae presented with dead insects in the pitcher fluid were adept at opening the corpses with their mouth hooks. They moved around the pitcher with the aid of the prominent creeping welts and by undulating the body.

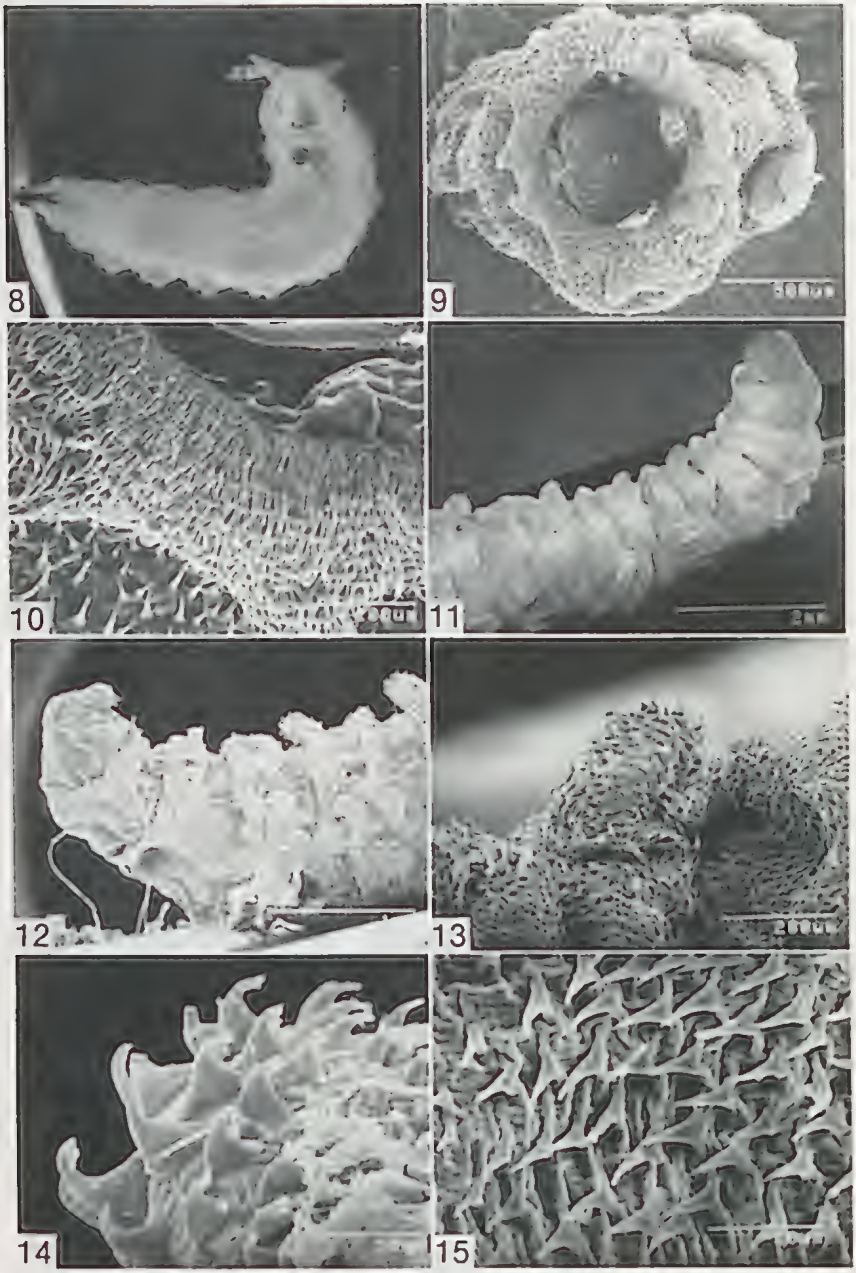
We dissected and examined the contents of numerous withered, senescent, pitchers that no longer contained fluid to determine whether the larvae pupated in the pitchers. As none of these contained puparia we concluded that the larvae leave the pitcher to pupate, probably in the soil. No doubt the recurved hooks on the creeping welts are important in allowing the maggot to scale the smooth internal walls of the pitcher and negotiate its recurved lip.

Large larvae placed in a dry substrate pupated there. The duration of the pupal stage was 7-15 days.

Discussion

The larvae of *S. papuensis* exhibit striking peculiarities compared with those of most sarcophagids: the anal segment is more elevated above the longitudinal axis of the body; the anal tubercles are longer; the creeping welts are much more prominent and the body is almost covered in small spines (in most sarcophagids larval spines are restricted to narrow bands). The posteriorly directed hooks on the ends of the creeping welts are much larger than the other body spines.

Figs 8-15. Mature larva of *S. papuensis*: 8, living larva floating at liquid surface with respiratory chamber open, exposing spiracles; 9-15 scanning electron micrographs; 9, posterior end showing respiratory chamber and anal tubercles; 10, detail of hydrofuge rim of respiratory chamber; 11, ventral view showing paired ventral creeping welts and smaller ventrolateral welts: 12, same, showing profile view of creeping welts; 13, detail of cuticular spines on creeping welt and surroundings; 14, detail of modified hooked spines on apex of welt; 15, unmodified spines found on lateral body surface.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The anterior spiracles of *S. papuensis* are also unusual amongst sarcophagids in that they have a larger number of branches that open in a clump rather than in a single fan-shaped row. In addition, the basal piece of the mouth hooks is poorly separated from the hook part and the latter lacks a ventral tooth.

Only three sarcophagids have been found in *Nepenthes* pitcher plants. Lever (1956) reported a *Sarcophaga* sp. larva from *N. sanguinea* Lindl. in Malaysia. Souza Lopes (1958) described *Sarcosolomonia carolinensis* (as *Bezziola*) from Palau in the Western Caroline Is, partly from larvae collected from *Nepenthes* pitchers. *Pierretia urceola* were described from *Nepenthes* pitchers in Malaysia (Shinonaga and Beaver 1979). In addition, larvae of four species of the genus *Fletcherimyia* Townsend (*F. fletcheri* (Aldrich), *F. rileyi* (Aldrich), *F. celarata* (Aldrich) and *F. jonesi* (Aldrich)) were collected from *Sarracenia* (Sarraceniaceae) pitcher plants in North America (Aldrich 1916). Larvae of *Sarraceniomyia sarraceniae* Riley and *Wohlfahrtiopsis utilis* (Aldrich) have also been collected from *Sarracenia* pitchers (Aldrich 1916).

Information is available on the morphology of *P. urceola* (Shinonaga and Beaver 1979) and *B. fletcheri* (Sanjean 1957). These larvae all share the pecularities noted above for *S. papuensis*. Most of these similarities were noted by Shinonaga and Beaver (1979) between *P. urceola* and *B. fletcheri*.

These two flies and *S. papuensis* belong to the subfamily Sarcophaginae (Souza Lopes *et al.* 1977). Although the similarities are probably parallel adaptations to a specialised habitat, examination of the morphology of closely related, non-pitcher dwelling larvae may shed further light on this question.

The only species of sarcophagid in *Nepenthes* for which there is detailed biological information is *P. urceola*. In contrast to our observations on *S. papuensis* larvae, Beaver (1979) found only one *P. urceola* larva per pitcher and that larvae confined together were cannibalistic. Forsyth and Robertson (1975) found *F. fletcheri* similar to *P. urceola* in these two respects. All three species appear to be mainly saprophagous and pupate in the soil.

The anal segment of the puparium of *S. papuensis* is not elevated as in the third instar larva.

The larvae of *S. papuensis* recorded here are the species that Monteith (1974) and Kitching and Pimm (1985) provisionally identified as syrphid larvae. Hoverfly larvae are known from *Nepenthes* pitchers (Hippa 1978) and other, smaller larvae noted during this study may be syrphids.

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